

ENVIRONMENT AND HOUSING MARKET

INCIDENT OF THE ENVIRONMENT IN THE PRICE OF THE DWELLING

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Abstract— The present paper studies the relationship between residential environment and building value. This allows us to know the elements of definition of the value of a particular housing market area and the variables that define that price. The objective of the research is to identify patterns within the residential housing market in the city area of Madrid.

Key-words - Dwelling; Residential Environment; Land Value; Location; Housing Market

I. INTRODUCTION

All the citizens have the right to enjoy an adequate and worthy dwelling (Spanish constitution of 1978, article 47.)

The terms of *dignity and adaptation* reflect more quantitative concepts than logical: it's difficult to establish the barrier till a dwelling is worthy (or adequate), but it is easy to compare two dwellings.

It is considered that both qualities are obtained from the sum of two types of factors:

- Intrinsic of the own dwelling.
- Environmental.

On a more concrete level, and considering the creation of the value of a building according to the generic formulation,

$$V_t = V_s + C_c + G + B \quad (1)$$

Where:

V_t = Building Value

V_s = Land Value

C_c = Construction costs

G = Promotion expenses

B = Promoter benefits

The Prices of construction are similar to the intrinsic characteristics of the dwelling, and the factors of environment to the land value. Both remaining addends, expenses and benefit, they will depend on them.

While the determination of the costs of construction can be easily analyse - the final amount of a building is the sum of the items involved in the construction - the land value, and its quantification, it is not easy to peel.

The land value depends on the demand, and that is what drives buyers toward one or another site, depending on the importance of each of the external parameters to the dwelling.

With regard to the remaining two addends, expenses, and benefit, will depend on those, as has been said above:

- Promotion expenses: previously known with some accuracy, depending on the characteristics of the promotion and on the costs of land and construction.
- The benefit, usually calculated as a percentage of the investment ($I = V_s + C_c + G$) (2), varies depending on the risk assumed in the promotion.

In summary, both expenses and profit depend on soil and construction, with the result that the value of a property will depend on them.

II. OBJECT OF THE WORK

Due to the construction costs vary depending on the specific features of a building, the scope of "uncertainty" in the price of housing to the value of the soil is limited.

The present study aims to analyze the incidence of certain environmental factors in the price of housing.

There have been considered the following factors for the study: communications, pollution, cleaning, exterior noise, citizen security and green areas.

The quantification of these parameters approaches us to the pressure of demand on each location. On the level of greed of the population respect a specific area, it proposes to obtain an intuitive idea of the influence of these factors. Using complex statistical tools, it is possible to evaluate the interest of this area of analysis.

III. STUDY FUNDAMENTALS

3.1 Working hypothesis

As has been mentioned, both dignity and adequacy of housing are quantitative aspects, and not absolute. In spite of this, in both cases, there is a great difficulty in regard to the measurement procedure to use.

To overcome this problem, there are recourses; this is, to parameterize the suitability of a dwelling according to different aspects, all of them quantifiable. Counting with the insurmountable subjectivity, this study is limited to assume the data available. We face, in the final analysis, the theory of the value as a subjective figure: what someone is willing to pay for something, depending on what that something gives.

3.2 Scope of the study

The present work focuses on the municipality of Madrid. The analysis is conducted on the basis of data obtained from the Population and Housing Census 2001, published in the document called: *Perception of the citizens of the Municipality of Madrid to the problems of their residential environment*. Published by the Madrid City Council. This document reflects the perception of the different issues in the environment, on the total of the houses in Madrid.

Therefore, from a few logical answers (YES/NO) raised to the totality of homes, with the results sorted by municipal neighborhoods to quantify the results, it is possible to establish links between these problems and the value of housing in the neighborhood.

The publication of the results of this survey by municipal districts is ideal for the application of the method of analysis used, for the following reasons:

- Existence of a database of 130 samples, corresponding to the neighborhoods of Madrid. In this case the samples correspond to a spatial agglomeration of all dwellings of 1st residence in the capital of Madrid, this is, 1,085,628 homes.
- Each of the data thus obtained refers to a homogenous zone.
- Possibility of crossing these data with those of average prices produced by appraisal companies and agencies, both public and private, use the same classification.

As the intrinsic aspects are translatable, ultimately they are used to analyze the impact of the environment on the value of the land for residential use - obviously, certain factors such as noise or pollution would have no impact on other uses, such as industrial use-.

Data on securities have been removed from the report: *Annual evolution of the price of second-hand housing in Barcelona and Madrid* published by Idealista, Libertad y Control, S.A. To draw conclusions, we analyzed a sample of 3,956 homes in the capital.

The data published in Idealista have been incorporated in the quarterly newsletter published by the Municipal Observatory of housing. All data are obtained by official sources.

3.3 Procedure.

To analyze the available data we use the linear regression (single and multiple,) also known as a method of least squares. For the application of this statistical tool, we transform absolute numerical data into percentage ratios, so that we can compare values:

Each of the parameters -factors of environment- studied has a percentage rating, so that 100% correspond with the best rating, the lack of perception of the problem in the corresponding quarter. The null responses have been valued with an incidence of 0.5.

The work includes an analysis of the incidence of each of the six factors of environment on housing prices, as well as a joint analysis of all of them.

3.4 Basics on the linear regression analysis

The regression models study the relationship stochastic (random) between a quantitative variable of interest and a set of explanatory variables.

The formal expression of the basic model of linear regression is made as follows:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \dots + \beta_k X_{ki} + u_i \quad (3)$$

Where:

- Y: it is the endogenous variable. This is the price of the square meter.
- X: each of the exogenous variables or explanatory.
- B: are the coefficients of each of the variables, the weight, for a quantification of the relationship between "Y" and each one of the "X".
- U: random perturbation, which reflects the combined effect of other variables not included in the. What is not explained in the formula, known as "error".
- I: sub index that references each of the observations

The data obtained from each analysis are: graph of the regression line, cloud of points with the data obtained, regression line, cloud of points with the prediction or forecast price, graph of waste, regression statistics and the different evaluators of the model (coefficients of determination and correlation and errors of the model.)

IV. LINEAR REGRESSION, SIMPLE ANALYSIS.

This section discusses factors of environment in relation to the price of the different neighborhoods of Madrid.

4.1 Quality of communications.

The data obtained in the surveys of the census embodied graphically on a map of Madrid "Fig. 1":

Lighter colors represent best communicated areas, which correspond to the most central districts.

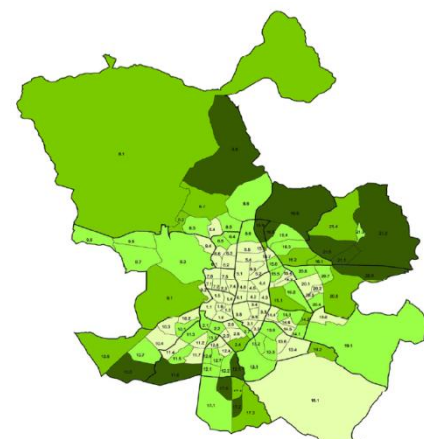


Figure 1. Quality of Communications.

It is noteworthy the rating obtained by peripheral districts as Latina and Carabanchel and, above all, the Historic Center of Vallecas.

Below are the results of a regression analysis “Fig. 2” (perception of the quality of communications and price.)

There is a direct relationship between the quality of communications and the price of housing, in terms of the mass of points, although there is some dispersal: the behavior of the cloud is actually swinging:

- The worst communicated areas correspond to peripheral areas, among which we can find both popular neighborhoods and residential neighborhoods with higher socio-economic status.

- The best communicated areas mainly corresponding to the Centre of the City, have the highest and lowest values, and the greater dispersion. It is more heterogeneous the Center than the periphery.

- The intermediate zones of the table -with regard to communications - correspond to intermediate neighborhoods, primarily in the northern half of the city, and have high prices.

The price increase in relation to the quality of the communications-, is determined by the constant 1,362.8.

The intersection with the horizontal axis is 1,150.8, which implies a very similar value to the previous constant: depending on the model, the relationship between the price in a neighborhood with communications with score 0% and another with 100% score would be 2.18 times in favor of the latter.

However, in high scores of communications, the variability of the price is higher.

4.2 Environmental Quality (vs. contamination and odors.)

This data refers to the perception of pollution problems and bad smells in the neighborhood “Fig. 3”.

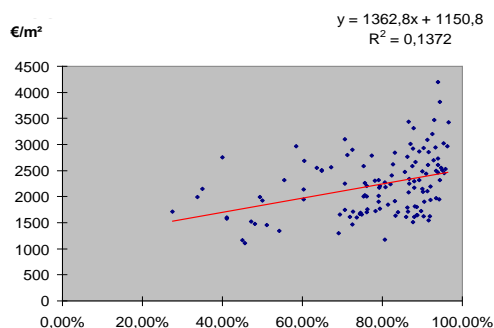


Figure 2. Communications Quality Regression.

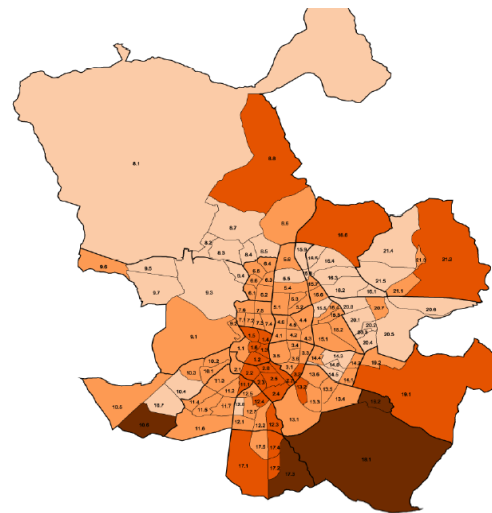


Figure 3. Environmental Quality.

The darker areas are more contaminated, which correspond to the neighborhoods of Vallecas and Cuatro Vientos.

The best valued neighborhoods are the intermediate zone of the North and the northwest axis. In the central neighborhoods there is an intermediate qualification, and a shaft poorly valued coincident with the exit to the south.

The constant (and slope) that relates the quality of the air with the price is virtually identical to that in the case of communications, while regression statistics are much less interesting “Fig. 4”.

The coefficient of correlation is somewhat lower than in the previous case, but the limit of determination tends to zero. Therefore, the model is not explanatory.

4.3 Citizen Security (vs. crime and vandalism.)

The image reflects the perception of this problem in the city presents a clear difference in a horizontal axis too. The hardest hit neighborhoods are the ones of the southern half again “Fig. 5”.

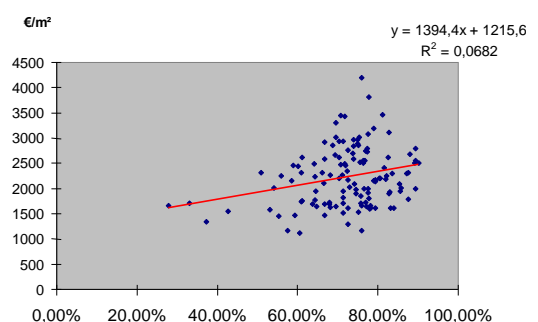


Figure 4. Environmental Quality Regression.

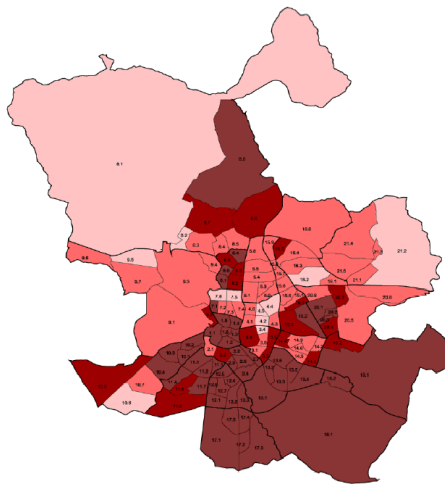


Figure 5. Citizen Security.

It should be noted that the darker areas correspond to neighborhoods where more than 40% homes detect this problem. It is a relatively low limit, so that it can be concluded that the crime is not a particularly serious problem in Madrid.

The slope of the line in this case is more pronounced, having greater incidence -greater weight - this variable of "citizen security" in the price of housing.

4.4 Cleanliness in the streets.

The geographical distribution of this parameter is more random than the previous ones. However, the worst valued neighborhoods are in the southern half again, with the exception of El Goloso, a neighborhood in the North, very poorly qualified "Fig. 6".

Regression statistics give similar results to the previous case, slightly more favorable.

The cloud of points has a seemingly similar distribution, but the regression line has increased slope: the cleaning of public spaces has more weight in the price of housing, with a coefficient of 2,960.7. In this scenario, the incidence of cleaning may be increased to make the price up to 6.6 times.

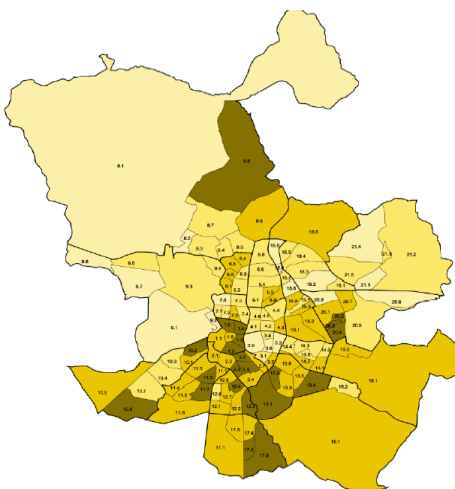


Figure 6. Cleanliness in the streets.

4.5 Noise Pollution.

This section discusses the problem of noise in different neighborhoods "Fig. 7".

The acoustic problematic is well distributed throughout the city, being a widespread problem. In the regression analysis, this variable is not representative; the statistics of the analysis are practically null values. The regression line is virtually horizontal, with a minimum weight of the variable "noise" in relation to the price .

The noise is not; therefore, a determining factor in the price of housing, except extreme cases as may be the case of Barajas.

4.6 Green areas.

The valuation of the staffing of green areas on the surface of Madrid is as reflects the figure "Fig. 8".

The best valued neighborhoods are at west zone, bordering the Monte del Pardo and Casa de Campo, as well as the District Retiro, and open block management neighborhoods, as can be Costillares (Pinar de Chamartin) or Palomeras.

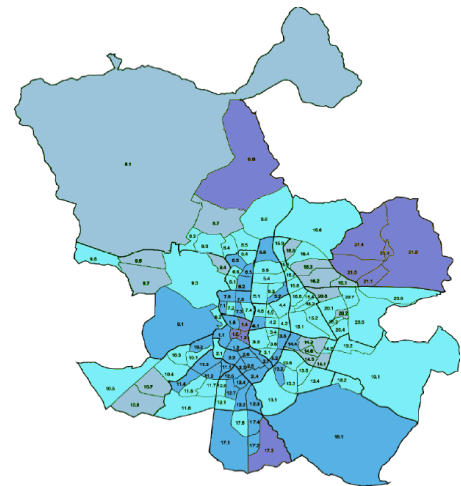


Figure 7. Noise Pollution.

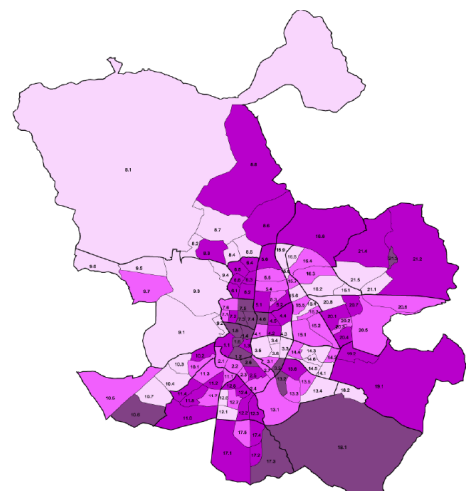


Figure 8. Green areas.

The worst valued are, in general terms, the historic centers, with a more constrained urban layout (Downtown District, the Historic Center of Barajas, Historic Center of Vallecas.) The statistics of regression analysis indicate that this is not an explanatory variable, with some correlation coefficients and determination virtually to zero.

Although, as in the rest of the analyzed variables, the relationship between the valuation of green areas and the price is positive (to better valuation, higher price) there is not a clear behavior with respect to this parameter. It is noteworthy that the highest price, corresponding to the neighborhood of La Castellana, has a much lower valuation than the average.

4.7 Conclusions of the Simple Regression Analysis.

Of the foregoing the following conclusions can be drawn:

- The factors with more weight in the price "Fig. 9" are cleanliness and crime, where it was overlapping all the straight regression obtained. The line called PRECIO is due to the reality of the existing data.

- The factor with less weight in the price is the existence of green areas. There is also a low incidence of noise in the price of housing, which may be due to the fact that this is a local problem that can be solved on an individual level.

- Factors that have more incidence (multiple correlation coefficient) are the same: crime and cleaning, followed by the communications (contrary to the first though.)

The coefficients appear previously mentioned, of correlation between the price and the variables studied, in the last line of the table (a). On the other hand, is tested as interrelated:

- Communications are not related to any of the other 5 factors, which are significantly interrelated.

- Cleaning is especially related to the crime.

- The existence of green areas is related to the other environmental factors: pollution, noise and clean the streets

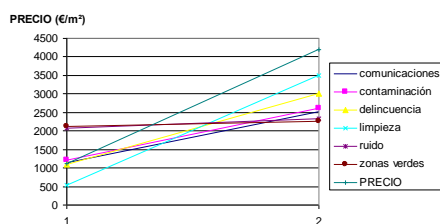


Figure 9. Environmental factors comparative.

	COMU NIC.	CONTA MIN.	DELINCU EN.	LIMPI EZA	RUIDO S	ZZ. VERDES	PRE CIO
COMUNIC.	1						
CONTAMIN.	0,1772	1					
DELINCUE	-0,0005	0,5332	1				
LIMPIEZA	0,0891	0,5771	0,7209	1			
RUIDOS	0,0188	0,4652	0,4292	0,2618	1		
ZONAS VERDES	-0,0426	0,5488	0,3786	0,5768	0,4951	1	
PRECIO	0,3703	0,2612	0,4966	0,5297	0,0395	0,0412	1

a. Correlation coefficients.

V. ANALYSIS OF MULTIPLE LINEAR REGRESSION.

As foreshadowed in the introductory sections, the data have been analyzed handled jointly. The possible combinations of variables for the study of multiple regression are many, as it can analyze the variables in groups of 2 up to 6 (in this case.) Once studied all the possibilities, then translate exclusively the analysis data set (6 explanatory variables), because this has been the most explanatory combination from a statistical point of view.

The obtained polynomial has been:

$$Y = 1.202 X_1 - 336 X_2 + 1.168 X_3 + 2.765 X_4 - 384 X_5 - 974 X_6 + 131 \quad (4)$$

Where:

Y average price (€/m²) in the neighborhood
X₁-X₆ rating of the various variables (%)

The regression statistics are more favorable than those above (simple regression.) Negative weights are displayed in the variables of pollution, noise and green areas (the "environmental", whose results had been less conclusive in the independent analysis), which does not seem logical.

Once eliminated these variables from the individual analysis and as a group, the regression statistics worsened. Therefore, we can conclude that the presence of these environmental variables qualifies the effect of the other three: communication, cleanliness and security.

Below there is a figure of some of the results in relation to one of the parameters. On this occasion the prognosis of price is not a straight line, but a cloud of points "Fig. 10".

The clouds of blue dots correspond to the distribution of values according to the field data. The cloud of pink dot corresponds to the result of price applied once the polynomial equation expressed above.

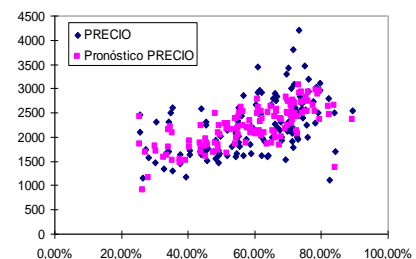


Figure 10. Crime dots cloud.

Blue dots distribution is the same than in the individual analysis. The pink dots tend to concentrate around the centre of gravity of the mass of points. It is observed that the higher prices are corrected to the low according to this model. By applying the polynomial formula to a neighborhood with best scores in all categories will get a value of 3.572 €/m². The maximum price in the base data is for La Castellana, 4.202 €/m², which are transformed into the model in 3,060 €/m², although remains the most expensive. The second better neighborhood valued, Viso, would be more punished in this model, since that of 3,814 €/m² would become 2.745 €/m², turning to the 10th position.

It was surprising to see that the neighborhood worst valued in the field data, Airport (1,100 €/m²) would have a price of 2.465 €/m² in this model, still in the top. There is, therefore, included in the price, factors that are not included in this model that greatly affect the price.

VI. DISTRICT ANALYSIS.

The analysis by districts softens the available results, but will allow us to analyze other data type. It has been estimated an average coefficient of the analyzed environment factors, which has been contrasted with the behavior of the price by districts "Fig. 11". It is clear that the behavior of the environment settings is relatively constant, while the price oscillates. The largest increases, isolated from the environment, occur primarily in the districts of the first expansions -Chamartín, Salamanca-.

On the other hand, the relationship of the price with the income has been analyzed "Fig. 12". The behaviour of both parameters is parallel. It is noted perhaps a slight offset of the unit price in the district of Moncloa-Aravaca, perhaps solved with a greater surface area of the houses.

VII. INTERPRETATION OF RESULTS

According to Roca Cladera, who exposes in his Manual of Real Estate Valuations, that there are three types of environmental factors that may influence the price:

- Accessibility: in this work has been analyzed the quality of communications.

- Urban qualification: embodied with the parameters of green areas, pollution and noise (the "environmental" factors.)
- Social hierarchy: represented by the data of crime and cleanliness of public spaces.

We can conclude that the most important factors are the socioeconomic: there is a city on the geographical distribution of the population based primarily on socio-economic criteria. Roca maintains the supply of real estate operates in disguised monopoly, "squeezing out" in each area the possibilities of demand: prices are set independently of the cost of production; the land market assumes the differential.

In this way, the population settles in the more expensive areas to which they have access, thus creating homogeneous spotting in the urban fabric.

Regarding the approach of the present study, it should be incorporated into the analysis another type of factors such as can be:

- Family Composition.
- Average dwellings size.
- Equipment.
- Relations with other uses.
- Proportion of rented housing/shelter in property.

With the step of neighborhoods to districts, samples are homogenized, which means losing part of the information of interest, but at the same time it enables to extract certain conclusions. The study at the district level confirms the preconceived ideas on the behavior of the housing price. It is therefore in minor scales where other differentiators that vary significantly the price.

Also, it would be feasible to predict/explain the behavior of prices in the greater part of the urban spectrum, but do not find scientific justification of the highest values, where more emotional criteria are involved.

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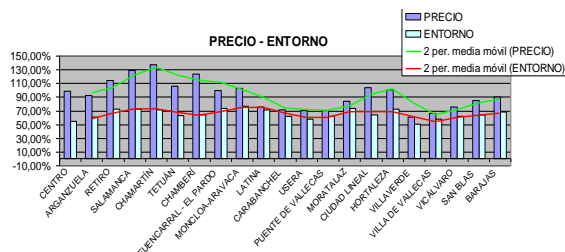


Figure 11. Relationship Price-Environment

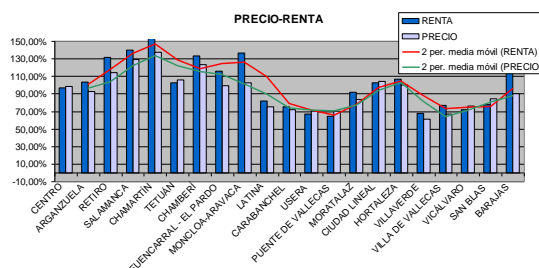


Figure 12. Relationship Price-Income.